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Serial No. 140

A PRELIMINARY REPORT ON THE AMES CREEK SMALL BUSH STUDY

By

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Title: A PRELIMINARY REPORT ON THE AMES CREEK SMALL BUSH STUDY

Purpose: To determine the infective potential of small Ribes lacustre in relation to losses of white pine as a basis for evaluating present control standards for the number and size of small bushes that can be safely left on a control area typical of Ames Creek.

Summary: The plot chosen for study was a 34-acre area on Ames Creek (Experiment Station Silvical Plot No. 61), Deception Creek Experimental Forest, Coeur d'Alene National Forest. The study area had been worked twice by eradication crews. The initial working was in 1934 prior to logging; the second working was performed in 1940, four to five years after the experimental logging which comprised alternate strips of clear-cut and shelterwood. The present disease study was made concurrently with eradication work undertaken in 1946.

Systematic line-plot sampling was adopted, the strips being run from creek-bottom to ridge-top. These sampling methods are intended to supply a measure of the losses caused by rust to the distributed stocking of white pine.

An analysis of weather data from 1936 to 1945 is given to correlate the history of rust development, most of which occurred during 1941. On the basis of 4-milacre units stocked with white pine in 1941, the 1941 infection caused only one per cent damage (stocking bases). Since 1941 the 4-milacre stocking damage has increased to about three per cent.

After the 1946 eradication a 20 per cent check showed 32 ribes and 32 feet of live stem. Four permanent sample strips have been established on the study area. These strips will be reserved for future studies on the spread of rust from small ribes. Completion of the study now awaits another favorable rust year such as occurred in 1941. Residual bushes on the area are small, well-screened R. lacustre, most of which are infected.

The 1947 inspection of pine and ribes shows some increase in pine infection, originating mostly during 1943 and 1944. Ribes were slightly larger and higher than in 1946, but the bushes were less generally infected and the leaves carried a smaller amount of rust. Apparently 1947 was not a year favorable to rust spread.

Spokane, Washington
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HRO/t

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Introduction and Purpose

During the summer season of 1946, a Ribes lacustre small bush study was established on Ames Creek, Northern Rocky Mountain Forest and Range Experiment Station, Deception Creek Experimental Forest, Coeur d'Alene, Idaho. The purpose of this study was to determine the infective potential of small ribes bushes on an area typical of this drainage. If blister rust sporidia from these characteristically small bushes are dissipated without inoculating many adjacent pines, particularly during years favorable to rust spread, then the eradication standards for these areas may be relaxed without lowering the effectiveness of blister rust control work. If the converse is true, it will be necessary to continue reworking toward the higher control standards or to abandon such areas because of high control costs.

The North Fork of the Coeur d'Alene River, of which Ames Creek is a subdrainage, is a stream of some 30 miles in length draining about four townships of western white pine timber land within the Coeur d'Alene National Forest. Conditions existing on the lower north and east-facing slopes of this river combine to make a difficult problem in ribes eradication. These slopes support large populations of small, screened R. lacustre bushes, some of which are passed over in the hand eradication work. Failure of average eradication crews to detect and remove these bushes has resulted in much of the area in the drainage failing to meet existing control standards. Economic limitations have made it necessary to question the value of continued reworkings in view of the unknown capabilities of such small ribes to spread the rust to adjacent white pines.

The northeast-facing slopes of Ames Creek were chosen as the study area. The creek runs in a northwesterly direction draining approximately 50 acres of cutover white pine land. Almost 34 of the 50 acres lie on the northeast-facing slopes, enclosed on three sides by well defined, timbered ridges and on the fourth by a steep valley bottom. These topographical factors have combined to make the northeast-facing slopes of the creek relatively well protected in relation to long-range spread of blister rust from other drainages or from the opposite slopes of the Ames Creek drainage (Figures 1 & 2). These slopes were known to support a heavy concentration of small R. lacustre bushes, originating either after experimental cutting and burning operations of several years ago or as missed bushes from an earlier eradication. The area was again scheduled for eradication work during the summer of 1946. In addition to ribes, the area supports a moderately well-stocked stand of western white pine reproduction in the 0 - 10 year age-class which is already infected by blister rust.

History of the Ames Creek Area

The 34 acre study area on Ames Creek is the Experiment Station's Silvical Plot No. 61, an experimental project in logging mature white pine timber, established in 1935. Logging was done in alternate clear-cut and shelterwood strips, three shelterwood strips, 4 to 5 chains wide, divided by two clear-cut strips, 4 to 7 chains wide. On the shelterwood strips, 28 mature white pines and 3 mature trees of mixed species were left per acre, allowing about 70 percent light to pass through the residual forest canopy. Slash on the shelterwood strips was piled and burned in 1936; that on the clear-cut strips was broadcast burned the same year. This single burn combined with favorable environmental conditions caused ribes seeds previously stored in the forest floor mantle to germinate abundantly. In 1938 (the fourth year after cutting) Moss recorded 254 ribes seedlings per acre in the shelterwood strips and 622 ribes seedlings per acre in the clear-cut strips. Over the entire area, about 5 percent of the seedlings were infected with blister rust. The extent of infection was one leaf on every other bush.

Two ribes eradication workings had been undertaken on the study area prior to 1946. The initial working, 1934, was before logging and removed about 6 bushes per acre from 77 acres including and surrounding the study area. The second working, during 1939 and 1940, was performed four to five years after logging while most of the ribes bushes were still small and difficult to detect. From 17 to 137 ribes per acre were eradicated by this second working.

From all indications, blister rust entered the reproduction stand in 1937 establishing itself on a few trees scattered over the study area. From 1941 to 1944 the rust intensified around these original centers and spread generally over the entire study area.

In 1938 the Experiment Station established five permanent reproduction transect lines on the study area to determine the effectiveness with which mature white pines remaining in the shelterwood strips would restock the area. Data taken on these transect lines are of value for comparison with the stocking estimates based on the sample taken in this study.

Methods

For purposes of this study, it was decided to employ a systematic, line-plot method of sampling. Advance examination showed that parallel sample strips five chains (330 feet) apart from creek-bottom to ridge-top would adequately sample the range of light, temperature, and moisture conditions affecting the ribes and pine reproduction on the study area. It was thought advisable to establish permanent sample strips on which the same ribes and pine populations could be studied during successive years. It was also believed best to follow the stocked-quadrat method of Haig, 1941, for the determination of population density and distribution of the ribes and pine reproduction. Accordingly, four permanent sample strips

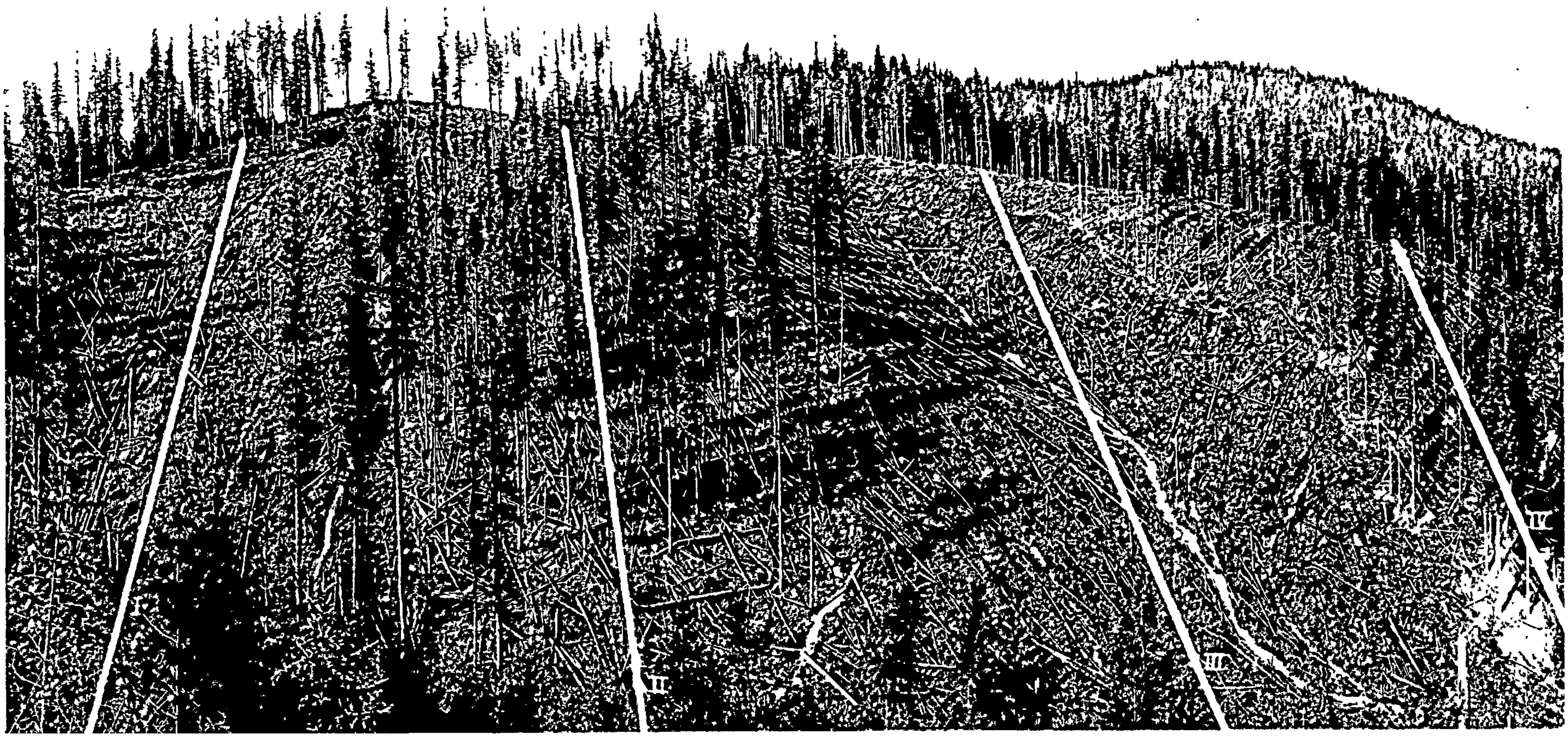


Figure 1. Deception Creek Experiment Station, Silvical Plot No. 61, showing the three shelterwood strips separated by clearcut strips. Sample strips I and III fall mostly in the open on the clearcut areas while strips II and IV fall mostly in the semi-shade of the shelterwood areas.

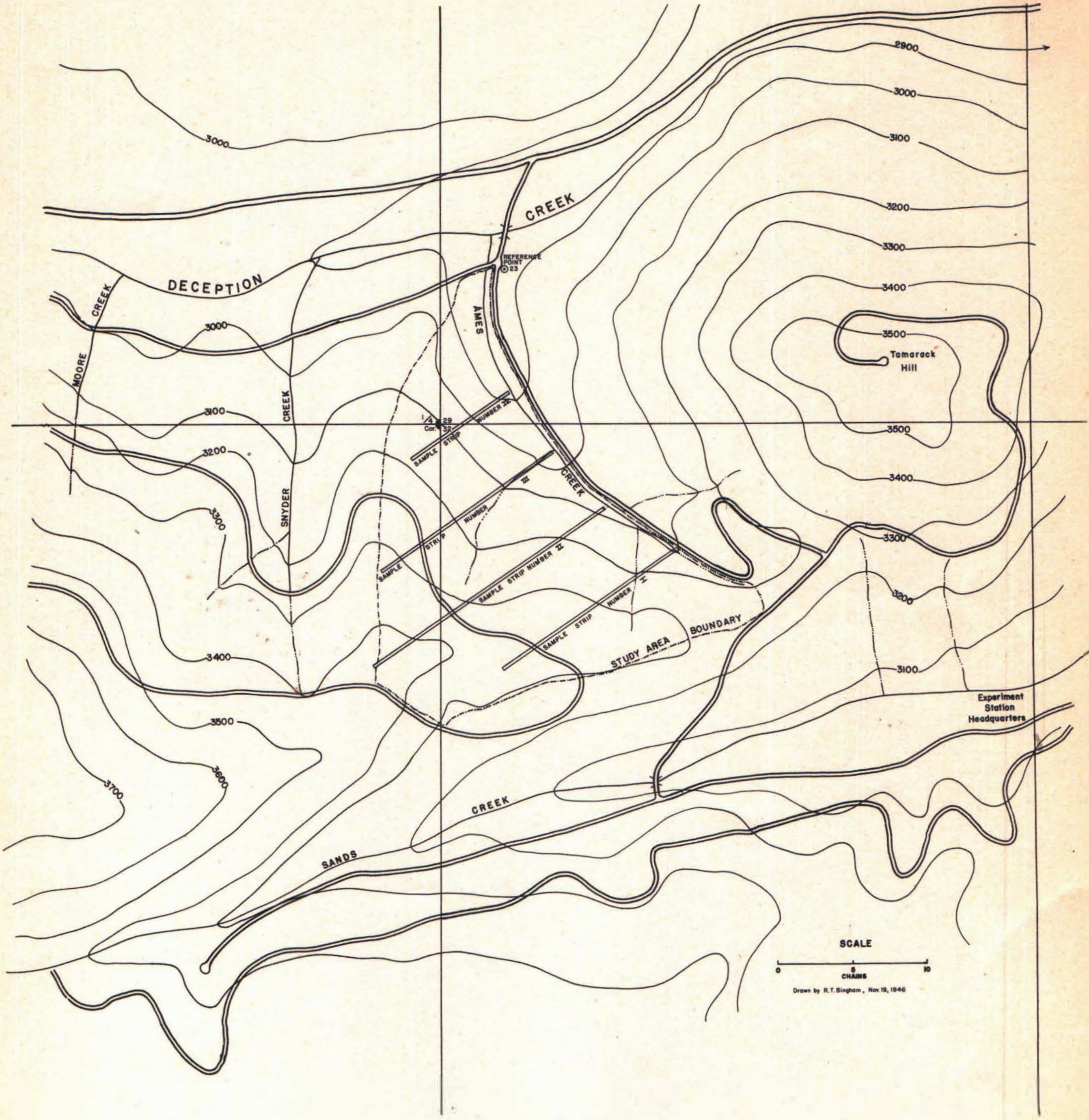


FIGURE 2.

AMES CREEK AND VICINITY SHOWING THE RIDGE AND STREAM BOUNDARIES OF THE 34-ACRE STUDY AREA AND THE FOUR PERMANENT SAMPLE STRIPS.

were established more or less directly upslope from the creek-bottom (Figure 2). These four strips were staked with cedar posts at one chain intervals and sub-staked with smaller cedar stakes at the center of each of the five 4-milacres intervening between posts (Figure 3).

In young age classes of white pine such as occur on the Ames Creek study area, nearly all infected trees will eventually succumb to the rust. The losses in stocking of white pine reproduction, however, cannot be accurately calculated merely from data on the percentages of the pines infected by the rust. A few of the blister rust cankers will die due to branch flagging, to the action of secondary fungi, or to natural suppression of branches. More important, the loss of an infected tree will have a different effect on distributed stocking than on total stocking. Spacing of the infected trees, not merely their number or the percentage of the total stand their number represents, is the important consideration. The space which a young infected pine occupies is much less than the space it would occupy, if alive, 40 years hence, or at maturity. Other healthy trees in the immediate vicinity can occupy the lost space when they become older and there is then no loss to the stand except in numbers, or in stand composition where inferior tree species occupy the space lost by white pines. A measure of stocking was needed which would express the distributed stocking losses caused by the blister rust fungus and since Haig's method fitted this requirement, it was used in this study.

Reference to Figures 3 and 4 will aid in understanding how estimations were made concerning total pine stocking, the distribution of the stock over the area, and the losses to the distributed stock caused by the rust. The method is based on a unit 13.2 feet square (4 milacres) which, when compared with western white pine yield tables, is found to be approximately the space required at rotation age by each tree in a fully stocked stand. The Ames Creek study area, a good site of about index 70, upon application to the yield tables, is found to be capable of supporting approximately 235 trees per acre at a rotation age of 120 years. Each tree would then occupy about 160 square feet or a square space of approximately 4 milacre size; the area would be considered 100 percent stocked if there were at least one pine occupying each of the 250 4-milacre units in each acre. Referring back to Figures 3 and 4, the 4-milacre unit "A" represented at the lower part of the "Pine Stem Map" would be considered stocked with healthy trees (Nos. 1, 3, 5 and 6) even though rust damaged trees (Nos. 2 and 4) are present within the unit. The 4-milacre unit "B", on the other hand, is lost space since it is stocked only by rust damaged tree number 7.

In order to get similar stocking and loss estimates for younger aged stands, identical data were taken using the milacre unit of stocking (6.6 foot squares representing the space required by each of 1,000 pines in a fully stocked stand of about 50 years of age). Figure 3 shows how each 4-milacre unit was subdivided into milacre units for purposes of recording data.

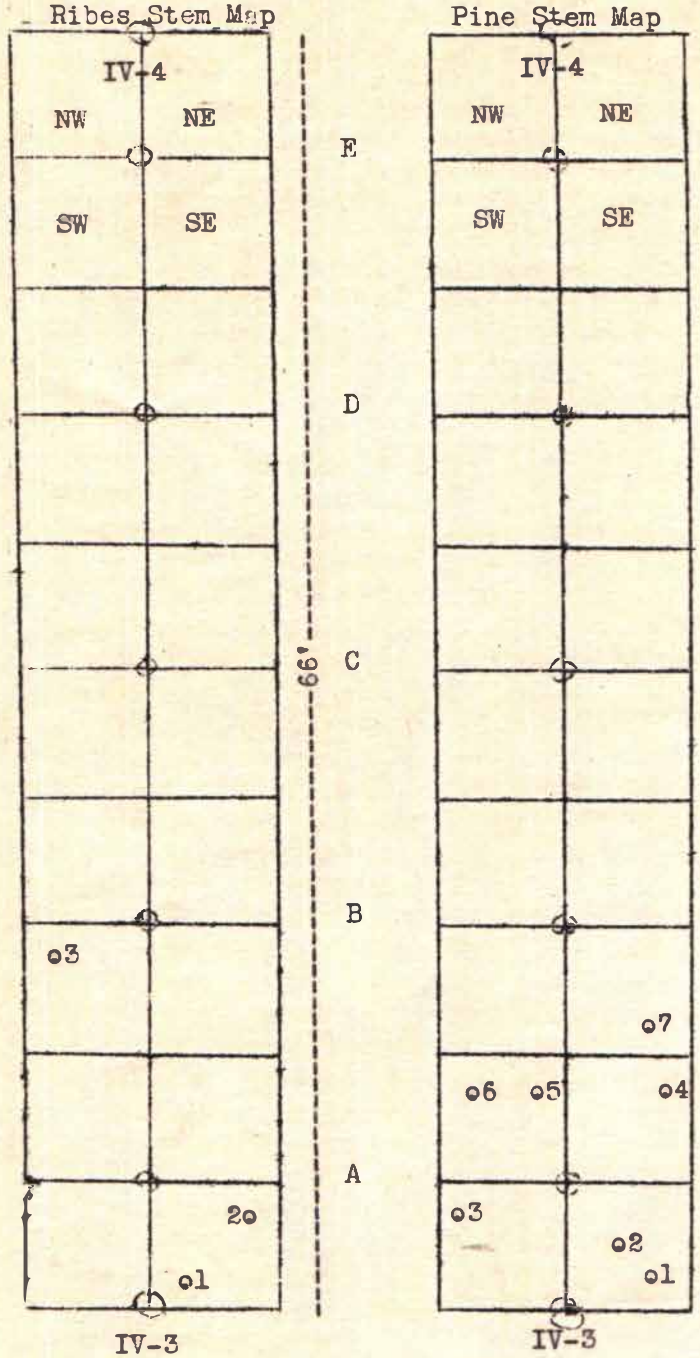
The history of the study area was such that a third eradication working was scheduled for 1946 to remove the previously missed and the newly established ribes. It was decided to work along with the eradication crews in order to secure data on the number, size, and distribution of the ribes as they were eradicated. In addition, similar data on the bushes present during 1941 were desired for use in interpretation of blister rust damage initiated during that extremely favorable year for rust spread. 1941 data were obtained by counting back the yearly nodes along the ribes stems to determine both the approximate year of origin of the bushes and the feet of live stem present for any particular year. Accordingly, eradication crews were followed closely as they covered the study area, each worker being instructed to present for inspection every tenth bush he eradicated.

Following this preliminary work, the permanent sample strips were systematically laid out starting from a reference point near the creek bottom. As it happens, these four strips fell naturally as though a stratified random sampling method had been employed; that is, the strips were representative of the more influential light, temperature and moisture variations occurring on the study area (Figure 1). The four sample strips, each 13.2 feet wide, totaled 55 chains (3,630 feet) in length, or a total area of 1.1 acres. As previously stated, strips were run directly upslope since blister rust infection, in which air movements and stream proximity are important factors, was under consideration. The Experiment Station's reproduction transects were placed more or less across slope since they are laid out for sampling pine stocking at various distances between the alternating clear-cut and shelterwood strip cuttings.

Strip No. IV — LOCATION DATA SHEET — Data Sheet #1

Transcept No. 3 — AMES CREEK, RIBES ERADICATION STUDY — July 15,1946

Ribes Stem Map — Pine Stem Map



Ribes Location

Number	Location	Year Found	FLS	Height
1	A-se	1946	2"	2"
2	A-SE	1946	11"	7"
3	B-NW	1946	6"	5"

Pine Location

Number	Location	Yr.of Origin	Height when found
1	A-SE	1940	1'-6"
2	A-SE	1939	1'-5"
3	A-SW	1936	3'-0"
4	A-NE	1940	2'-3"
5	A-NW	1942	0'-7"
6	A-NW	1941	1'-2"
7	B-SE	1936	3'-6"

Figure 3.

Data sheet used for permanent records of pine and ribes in each one-chain transect. Transects are represented diagrammatically in the stem maps as rectangles 13.2 x 66 feet in size. On the ground only the end stakes at the extremes of the transects (IV-3 and IV-4) and the milacre center sub-stakes (A, B, C, D, and E) are present. During annual inspections a 13.2 foot pole is carried to determine transect and quadrat boundaries.

Strip No. IV
Transect No. 3

Data Sheet #2
July 15, 1946

ANNUAL INSPECTION SHEET

AMES CREEK RIBES, ERADICATION STUDY -- RIBES AND PINE INFECTION, PINE STOCKING

RIBES DATA FOR YEAR 1946 INSPECTED Aug. 15, 1946

Bush Desig.	Year Found	Height Bush (nearest ½")	Total Live Stem (feet & inches)	Bush Exposure	No. &&% of leaves infected	Sq.mm. of leaf surface infected
1	1946	0'-2"	0' - 2"	Screened	0 - 0%	0 (All new leaves)
2	1946	0'-7"	0' -11"	Open	3 - 19%	45
3	1946	0'-5"	0' - 6"	½ Screen	7 - 65%	110 (Inf. leaves ½ cast).
etc.						

PINE DAMAGE AND STOCKING DATA FOR YEAR 1946 INSPECTED Sept. 7, 1946

Tree Designation	Year Found	Ht. of tree (ft.& in.)	No. cankers	Description of cankers	Prob. yr.of Inf.	Number trees in milacre	No.dmg'd. trees in milacre	Mi acre damaged?	4-Milacre Damaged?
1	1946	1'-6"	0	-	-				
2	1946	1'-5"	2	441.	44				
				40Fs Stem	41	2	1	No	
3	1946	3'-0"	0	-	-	1	0	No	
4	1946	2'-3"	1	41 F	41	1	1	Yes	
5	1946	0'-7"	1	-	-				
6	1946	1'-2"	0	-	-	2	0	No	No
7	1946	3'-6"	1	40Fs Stem	41	1	1	Yes	Yes

Figure 4.
Data sheet used for annual tabulation of ribes, pine, and pine infection data.

Discussion and First Year Results

1. Climatological Conditions Existing on the Ames Creek Study Area During 1941.

Climatological data accumulated for the ten years from 1936 to 1945 at the Deception Creek Experimental Forest Headquarters, an approximate distance of one-half mile from the Ames Creek study area, are presented in Tables I and II. The data demonstrate how climatological factors combined to make 1941 the most optimal for rust intensification and spread of any year in the past ten. This information is considered because the capability of small ribes to infect adjacent pines is closely dependent on weather conditions and because the completion of this study hinges on another such combination of weather and rust to produce a wave year like 1941.

Referring to Table I, it is seen that May to September weather data in 1941 differ greatly from the ten-year means in most of the climatic factors considered. Starting with May, 1941 records and progressively examining the data through September, the following facts stand out: (1) May was extremely wet, (2) July was extremely dry, (3) August was moderately rainy, and (4) September was excessively rainy, overcast and cold and had an exceptionally late first frost. Considered in the light of the requirements of the rust, these facts partially answer the question as to why 1941 was such an optimal year for blister rust infection.

Beginning with the snow run-off which usually takes place on Ames Creek from early May to mid-June, and progressing through the aecial sporulation season of the rust (late May to mid-July), it is noteworthy that although May and June rainfall was heavy (8.46 and 3.30 inches, respectively) only 0.24 inches of rain fell during July. In view of certain experimental evidence concerning weather and the requirements of the rust fungus, the extremely wet spring and exceptionally dry early summer make it difficult to estimate the extent of initial ribes infection with aeciospores of the rust. Mielke has observed that although 8 to 12-hour rainy periods are required for the germination of aeciospores, the abnormally wet weather of northern Idaho during the main period of aeciospore production (mid-May to mid-June) in 1941 curtailed the initial infection of ribes by aeciospores during that season. Prevention of initial infection may have been due to the washing of aeciospores from the air as reported by Spaulding, or to the washing of spores directly from the aecia and their germination in the aecia as reported by Pennington. Since both Mielke and Spaulding have pointed out that _R. lacustre_ is not a species in which rust infection builds up through uredial intensification, but rather one in which greater susceptibility to aecial inoculum may be the important factor in determining the degree of infection, it is difficult to explain the relatively heavy infection found on _R. lacustre_ by Stillinger later in the season. Perhaps the drier late June and July weather near the end of the period for aeciospore production was more favorable for aeciospore dissemination.

Hirt has shown that for the production and germination of the rust fungus sporidia, and for the subsequent inoculation of pine needles, a closely limited range of light, moisture, and temperature conditions must prevail. The production and germination of sporidia were found to be sharply curtailed at temperatures above 70° Fahrenheit, the optimal temperature range being from 54 to 64° F. Relative humidities of from 96 to 100 per cent were required for sporidia production and from 97 to 100 per cent for sporidia germination with direct water contact optimal. Direct sunlight lengthened the time required for the production of sporidia and affected their germinability to the extent of reducing the number of germinable sporidia 95 per cent in seven hours. In addition to these requirements for each individual step in the chain of events leading to pine infection, the duration of the required light, temperature and moisture levels is of course extremely important. Mielke estimated that these conditions must persist for a period of at least 24 to 36 hours in order for abundant pine infection to take place. Table II shows the duration of the required cold, wet and overcast periods. It can be seen that from August 24 to September 30 the maximum and minimum temperatures did not once leave the limits for the production and germination of sporidia and that for only a few days of this period did the temperatures leave the most optimal range for production and germination of sporidia (54-64°F.).

TABLE I
CUMULATIVE AND MEAN MONTHLY CLIMATOLOGICAL DATA, DECEPTION CREEK EXPERIMENTAL FOREST, 1936 - 1945

Year	Cumulative Monthly Rainfall (In.) May	June	July	Aug.	Sept.	Mean Temp.(°F.) Aug.	Sept.	Date of First Frost (Temp. 32° F. or lower)
1936	2.45	4.13	0.92	0.72	1.92	59.9	51.3	August 31
1937	1.70	6.02	1.25	2.12	1.74	56.9	53.9	August 15
1938	1.69	1.91	0.33	1.04	1.16	57.4	58.5	August 3
1939	1.10	4.06	0.85	0.04	1.93	60.5	53.6	July 17
1940	2.18	1.18	1.28	0.24	4.21	60.3	58.3	August 14
1941	8.46	3.30	0.24	1.63	5.35	61.0	49.4	September 21
1942	5.67	4.88	1.43	0.33	0.28	61.4	54.2	August 27
1943	4.41	3.30	0.52	0.83	0.34	58.2	53.6	September 3
1944	4.14	1.53	0.92	2.08	3.91	59.0	55.4	August 20
1945	3.71	2.21	0.00	1.06	*2.55	61.9	-- *	August 21
Means	3.55	3.25	0.77	1.01	2.33	59.7	54.2	August 20

(*) Record incomplete, Sept., 1-8 only

TABLE II
DAILY CLIMATOLOGICAL DATA, DECEPTION CREEK EXPERIMENTAL FOREST, AUGUST AND SEPTEMBER, 1941

Date	August Temp. °F. Max.	Min.	Rel.Hum.% Max.	Min.	Rain,(In.) Amt.	Hrs.	Cloudiness*	September Temp. °F. Max.	Min.	Rel.Hum.% Max.	Min.	Rain,(In.) Amt.	Hrs.	Cloudiness*
1	73	41	100	36	0.00	0	C	63	48	100	79	0.13	13¾	OC
2	69	41	100	54	Trace	½	OC	60	51	100	94	0.14	14½	OC
3	69	46	100	58	Trace	?	OC	54	48	100	100	0.28	18	OC
4	65	48	100	79	Trace	?	OC	64	47	100	78	0.71	24	OC
5	78	50	100	39	0.05	?	SC	67	42	100	47	0.00	0	SC
6	80	37	100	27	0.00	0	C	60	43	100	60	0.12	3	BC
7	86	37	100	26	0.00	0	C	61	40	100	46	0.09	7½	BC
8	85	40	100	30	0.00	0	OC	61	33	100	50	0.00	0	OC
9	85	53	100	39	0.00	0	C	56	44	100	94	0.52	?	OC
10	92	47	100	29	0.00	0	C	60	41	100	82	0.14	24	OC
11	86	50	100	35	0.00	0	OC	56	44	100	71	0.31	7	BC
12	75	55	100	75	0.07	12	OC	54	40	100	93	0.38	24	OC
13	75	54	100	59	Trace	?	BC	51	42	100	93	0.18	24	OC
14	87	50	100	34	0.00	0	SC	53	45	100	65	0.21	24	OC
15	84	50	100	40	0.07	5	BC	54	40	100	71	0.74	24	OC
16	82	50	100	29	0.03	3	C	58	36	100	72	0.00	0	OC
17	81	40	100	34	0.00	0	C	57	45	100	85	0.01	?	OC
18	83	41	100	28	0.00	0	C	56	43	100	100	0.84	?	OC
19	83	41	100	42	0.00	0	SC	53	39	100	73	0.10	24	OC
20	85	45	100	37	0.00	0	BC	50	36	100	84	0.07	7	BC
21	84	44	100	38	Trace	2¼	BC	58	32	100	46	Trace	?	SC
22	82	48	100	38	Trace	½	OC	65	30	100	48	0.00	0	C
23	77	49	100	72	0.09	2½	OC	70	34	100	46	0.00	0	C
24	66	47	100	50	0.03	?	BC	67	38	100	52	0.00	0	SC
25	70	36	100	39	?	10½	BC	70	39	100	51	0.00	0	BC
26	68	51	100	74	0.28	8½	OC	63	42	100	34	0.03	7	BC
27	62	48	100	61	0.77	9½	OC	55	34	100	49	Trace	?	SC
28	64	41	100	56	0.22	7½	BC	61	24	100	43	0.00	0	OC
29	69	41	100	44	0.00	0	BC	60	38	100	55	0.01	7	SC
30	64	35	100	35	Trace	¼	BC	52	36	100	76	0.34	11	OC
31	68	47	100	50	0.02	?	BC							
Means	76.7	45.3	100.0	44.7				59.0	39.9	100.0	66.9			
Totals					1.63	62						5.35	263¼	

*Cloudiness measured by weather observer as Clear (C) when less than 10% of the sky is covered by clouds, as Scattered Clouds (SC) when 10-50% of the sky is covered, as Broken Clouds (BC) when 60-90% of the sky is covered, and as Overcast (OC) when more than 90% of the sky is covered.

Precipitation and relative humidities for the same period were high. Daily minimum relative humidities were taken in the open, grass-sodded weather station enclosure and were probably lower than those on the timbered and brush covered slopes of Ames Creek. (Note that despite continuous rainfall for the period from September 12 to 15, the minimum relative humidities were as low as 65 per cent.) It is also noteworthy that direct sunlight, detrimental to sporidia, was largely eliminated by clouds during the entire month of September. Combining all these requirements and examining Table II for periods which met all the conditions, it can be seen that August 26 to 28, August 31 to September 4, September 9 to 15, and September 19 to 20 could all have been periods of sufficient duration to fulfill requirements in the 36-hour chain of the sporidial production, germination and infection cycle.

2. Characteristics of the Ribes Present on the Ames Creek Study Area in 1941.

Data for ten per cent of the ribes bushes removed by eradication crews in 1946 are shown in Table III. A total of 640 bushes was examined in detail and of these 617 were identified as having been seedlings prior to 1941. Per acre totals were neither exceptionally high nor low for the North Fork area, the estimates from the sample being 180 bushes with 100 feet of live stem for 1941, and 187 bushes with 607 feet of live stem for 1946.

TABLE III. RIBES ERADICATED FROM STRING LANES DURING 1946 WORKING OF THIRTY-THREE AND TWO-THIRDS ACRES ON THE NORTHEAST-FACING SLOPES OF AMES CREEK

String Lane Number	Number Bushes Examined	Est. Number Strip Bushes	No. Bushes by Yr. of Origin 1941 & Earlier	No. Bushes by Yr. of Origin 1942& Later	Feet of Live Stem by Years 1941	Feet of Live Stem by Years 1946	String Lane Number	Number Bushes Examined	Est. Number Strip Bushes	No. Bushes by Yr. of Origin 1941 & Earlier	No. Bushes by Yr. of Origin 1942& Later	Feet of Live Stem by Years 1941	Feet of Live Stem by Years 1946
1	0	0	0	0	0.0	0.0	35	6	60	60	0	15.3	57.5
2	0	0	0	0	0.0	0.0	36	35	350	350	0	95.8	442.5
3	6	60	60	0	90.0	612.5	37	17	170	170	0	43.7	150.0
4	8	80	80	0	31.7	330.0	38	20	200	200	0	82.5	417.5
5	12	120	120	0	56.7	482.5	39	4	40	40	0	5.4	42.5
6	3	30	20	10	1.0	10.0	40	10	100	100	0	48.3	232.5
7	0	0	0	0	0.0	0.0	41	20	200	200	0	168.3	917.5
8	19	190	190	0	172.1	1457.5	42	12	120	120	0	147.5	647.5
9	7	70	70	0	42.1	278.8	43	11	110	110	0	65.0	380.0
10	0	0	0	0	0.0	0.0	44	8	80	80	0	90.0	452.5
11	7	70	70	0	10.0	37.5	45	10	100	100	0	58.8	280.0
12	5	50	40	10	25.0	83.3	46	14	140	130	10	89.6	572.5
13	13	130	130	0	90.0	497.5	47	10	100	90	10	28.8	152.5
14	9	90	90	0	22.1	100.0	48	5	50	50	0	13.8	57.5
15	13	130	120	10	87.9	655.0	49	14	140	140	0	27.9	141.3
16	21	210	210	0	39.2	202.5	50	10	100	100	0	51.7	315.0
17	15	150	140	10	58.3	403.8	51	16	160	160	0	78.7	325.0
18	15	150	130	20	60.0	500.0	52	11	110	110	0	20.4	111.3
19	3	30	30	0	33.8	260.0	53	16	160	150	10	67.1	235.0
20	11	110	110	0	32.1	295.0	54	17	170	160	10	78.7	410.0
21	20	200	190	10	75.8	585.0	55	16	160	150	10	74.2	315.0
22	20	200	180	20	93.7	810.0	56	11	110	110	0	85.8	600.0
23	13	130	130	0	61.2	495.0	57	9	90	90	0	64.2	387.5
24	17	170	160	10	346.2	2185.0	58	11	110	110	0	83.3	417.5
25	14	140	130	10	111.3	740.0	59	3	30	20	10	3.8	55.0
26	13	130	110	20	42.9	387.5	60	3	30	30	0	8.8	105.0
27	3	30	30	0	2.1	25.0	61	4	40	40	0	37.5	90.0
28	1	10	10	0	0.8	15.0	62	3	30	30	0	10.0	50.0
29	4	40	40	0	10.0	27.5	63	6	60	60	0	29.2	95.0
30	5	50	40	10	13.3	35.0	64	2	20	20	0	2.1	25.0
31	6	60	50	10	5.4	47.5	65	1	10	10	0	10.0	30.0
32	4	40	40	0	13.8	42.5	66	0	0	0	0	0.0	0.0
33	4	40	40	0	3.7	37.5	67	2	20	20	0	20.0	110.0
34	7	70	50	20	10.8	57.5	68	5	50	50	0	10.4	50.0
Totals							68	640	6400	6170	230	3369.6*	20456.0*

(*) Totals of feet of live stem for 1941 and 1946 put on a per acre basis are equivalent to 180 bushes with 100 feet of live stem in 1941 and 137 bushes with 607 feet of live stem in 1946.

TABLE IV. FREQUENCY DISTRIBUTION BY FEET OF LIVE STEM SIZE CLASSES AMONG AMES CREEK RIBES, 1941 AND 1946

Size Class Feet of Live Stem	Number Bushes Size Class in 1941	Number Bushes Size Class in 1946
Seedling- 0.1	203	13
0.2- 0.5	288	143
0.6- 1.0	74	140
1.1- 2.0	31	154
2.1- 5.0	15	106
5.1- 10.0	5	51
10.1- 50.0	1	29
50.1- 100.0	0	3
100.1- Plus	0	1
Totals	617	640

Other characteristics of the Ames Creek ribes are also apparent in Table III. The first is that under conditions similar to those existing during the opening of the mature stand in 1935 and 1936, it could be expected that the greater proportion of the stored R. lacustre seed would germinate in a relatively short period of time. This point is demonstrated by the fact that only 23 of the 640 examined bushes (3.6 per cent) became established after 1941. A second point is that the number and size of bushes are extremely irregular between the various string lanes. This is due to some extent to the length of the string lanes but probably more to the variation in the amount of light between lanes. A third point is the marked increase in total amount of live stem during the four years 1942 to 1946. Live stem increased about six times during this period, from an estimated 3,369 to 20,456 feet.

Although the approximate number of ribes bushes and the footage of live stem could be calculated for 1941, the resulting figures could not be applied in determining the infective potential of a given number of small bushes for reasons hereunder stated. As eradication work progressed on the study area it became apparent that there were large bushes, some with as much as 20 feet of live stem, present on the area in 1941. Table IV shows the sizes and numbers of the bushes present in 1941 and 1946. It will be noticed that in the 10 per cent sample there were 21 bushes having more than two feet of live stem in 1941. This means that about 210 large to medium-sized bushes were then present over the entire study area, about six bushes per acre, in 1941. Since it is believed that average eradication crews would have found and removed most bushes of this size, no attempt will be made to interpret 1941 pine infection as coming from a typical small bush pattern. Rather, 1941 infection must be interpreted as coming from about six large and medium-sized bushes plus about 174 small bushes per acre.

3. Pine Infection and Blister Rust Losses on the Ames Creek Study Area During 1941 and Later Years.

Of hundreds of pines examined on the study area as eradication work progressed, only one infection center of 1937 origin was found (near

¼ corner 29/32, Figure 1). On the closely examined pines of the permanent sample strips no cankers were found on internodes originating earlier than 1939. Presumably then, initial infection of pines in the Ames Creek drainage took place in 1937. These few blister rust cankers would have scattered aeciospores over the area by 1941. Mielke reported that it is not unusual to find ribes infected over 300 yards from the source of aecial inoculum so that this 1937 infection center, plus other undetected centers on or near the study area, may have been responsible for a light but general infection of bushes present on the study area in 1941. Due to the characteristic lack of uredial build-up on R. lacustre there was probably not much rust intensification on the ribes during the summer. However, spread to pine occurring under the almost optimal weather conditions of the fall of 1941 was probably disproportionately great. Table V shows all pine infection to date, broken down as to age-stage of cankers and as to year in which infection occurred as estimated by Pennington and Lachmund's 1933 system.

TABLE V. YEAR PINE WOOD INFECTED, STAGE OF CANKER AND ESTIMATED YEAR IN WHICH INFECTION OCCURRED FOR FIFTY-ONE CANKERS EXAMINED ON FOUR PERMANENT SAMPLE STRIPS ON THE AMES CREEK STUDY AREA.

Strip Number	Canker Age-Stage *																Estimated Year of Infection			
	1939	1940			1941					1942				1943		1944				
	Fl	Ps	Fl	Fs	J	Ps	Fl	Fs	D	J	P	Ps	Fl	I	J	I	1941	1943	1944	
I			1			3	2	1		2	1	2			2		7	5	2	14
II	2	1	3	2			4	2		1	2		1		1		14	4	1	19
III				1		1	2			3				1			4	3	1	8
IV				4	1				1	1		1			1	1	6	2	2	10
Totals	2	1	4	7	1	4	8	3	1	7	3	3	1	1	4	1	31	14	6	51

(*) Canker stages abbreviated as follows: I - Incipient; J - Juvenile; P - Pycnial, scars of current season only; Ps - Pycnial Scars, scars from previous years; Fl - Aecial, scars of current season only; Fs - Aecial, scars of more than one season; D - Dead.

The first thing to be noted in Table V is the total of only 51 cankers on which to base year of infection estimates. When these 51 cankers are subdivided among the various age-stage classes few significant conclusions may be drawn as to the actual years in which pine infection occurred. 1941 weather conditions, plus the rather well-defined grouping of older cankers on 1939 to 1941 wood, make cankers on internodes of those years quite surely of 1941 origin (see data Table V). Cankers originating on 1942 to 1944 internodes are not so easily relegated to the years in which infection occurred. Since the small numbers of cankers on 1942 to 1944 internodes form no characteristic pattern, weather data and Lachmund's findings (over 50 per cent of cankers originate on internodes one year old at the time of infection) were employed in estimating the year in which

infection occurred. Reference to Table I shows that none of the years between 1942 and 1944 was especially good for blister rust infection. Of the two years 1942 and 1943, the latter was the better for dissemination of aecial inoculum. It also had more rainfall during the telial-sporidial season and had the latest first frost. The year 1944 appears to have been the most favorable of the three for infection but its extent cannot be determined at this early date.

Proceeding with the analysis of pine infection data, it is of interest to determine the percentage of white pine reproduction infected over the study area. It is also of interest to break this infection data down in the light of how much reproduction was present on the area during successive years and of the corresponding percentages infected. The shelterwood overstory, in producing seed, has continued to increase stocking on both shelterwood and clear-cut strips. Hence, such percentages of infection should be calculated on the basis of the amount of reproduction present during the year in which infection took place. Table VI summarizes this information.

TABLE VI. PERCENTAGE OF INFECTION BASED ON THE NUMBER OF TREES PRESENT DURING THE YEAR IN WHICH INFECTION OCCURRED.

	Years in Which Infection Occurred				Present Stocking
	1937	1941	1943	1944	1946
Number of Trees on Sample Strips	104	501	567	575	587
Estimated Number of Trees Per Acre	95	455	515	523	534
Percentage of Infection	?	5.4	7.1	*7.8	*7.8
Residual Uninfected Stand Per Acre	95	430	478	482	492

(*) Percentages are probably low as cankers originating in later years have not all become visible.

Table VI discloses that the Ames Creek reproduction stand is still on the increase and that the number of new trees has exceeded the number infected each year. The residual uninfected reproduction stand has increased from 95 trees per acre in 1937 to 492 trees per acre in 1946. The table also shows there was a total of 534 trees per acre present in 1946 of which 492 were healthy, an apparent loss, due to blister rust, of 42 trees per acre or 7.8 per cent. This loss figure will be examined later in the light of similar loss figures calculated, using the stocked-quadrat method.

Stocking and blister rust damage data taken on the four permanent sample strips using the stocked-quadrat method are shown in Table VII. It has already been pointed out that even in the younger age classes certain of the infected trees escape fatal injury by virtue of the death of rust cankers on their branches. Table VII shows that 3 of the 51 infected trees escaped injury in this manner and that of the 7.8 per cent of the trees infected only 7.2 per cent are lost. In addition, the lost or damaged trees are so distributed on the sample strips that they represent less of an actual loss to the distributed stocking. Up to the present

time the loss in stocking has been 19 units on the basis of milacres and 6 on the basis of 4-milacres. Thus it can be seen that the reproduction stand, which is at present 53.3 per cent stocked by the milacre unit system, has suffered a loss of only 5.2 per cent of the stocked milacres. Similarly, the stand 68.4 per cent stocked by the 4-milacre unit system, has suffered a loss of only 3.2 per cent of the stocked 4-milacres.

When interpreted in the light of infection which took place in 1941, the damage data in Table VII show that in 1941 ten of the stocked milacres and only two of the stocked 4-milacres represented losses in stocking due to blister rust. Corresponding percentages of losses are 3.0 and 1.1, respectively.

A comparison of 4-milacre stocking estimates based on the permanent sample strips of this study, with those based on the Experiment Station's reproduction transects, follows:

Av. % full 4-milacre stocking based on Experiment Station Transects,1939 - 18
Av. % full 4-milacre stocking based on sample strips, this study, 1941 - 64
Av. % full 4-milacre stocking based on Experiment Station Transects, 1943 - 64
Av. % full 4-milacre stocking based on sample strips, this study, 1946 - 68

Percentages of full 4-milacre stocking obtained on the Experiment Station's reproduction transects are lower than those obtained on the four sample strips in this study but this is believed mostly due to a difference in the method of recording data. On the Experiment Station transects only white pines six inches and taller were considered, whereas in this study all white pine reproduction including current year seedlings was included.

In summarizing results of the estimations of blister rust losses to white pine stocking, it is again emphasized that they are based on a relatively small number of infected trees. On the basis of this small sample it would appear that 1941 infection had but a slight effect in reducing distributed stocking on the study area. Later infection has about doubled the loss, but it is still so small that distributed stocking may be considered relatively undisturbed up to the present time.

4. Present Control Status of the Study Area.

At the conclusion of the 1946 eradication work a 20 per cent systematic sampling or check was made of the study area to determine the number and characteristics of ribes remaining on the area. A sample of this size was considered necessary since a four per cent sample of the ribes population (approximately the intensity of check obtained from the four permanent sample strips) has been found by Fracker and Brischle, 1944, to be of doubtful accuracy when applied to a thinly and unequally distributed ribes population on a small acreage. The large sample has proved useful in determining the accuracy of the sample based on the four study strips. This is important because when the study area is examined in future years changes in numbers and characteristics of ribes over the entire area will be estimated from changes which have occurred on the sample strips. Results of the 20 per cent check are summarized below

so that a comparison between estimates based on this large sample may be made with estimates based on the sample strip data of Table VIII.

Total number of ribes bushes on all check strips	214
Number of infected bushes	184
Percentage of bushes infected	80.0
Average number of bushes per acre	32
Total feet of live stem in bushes on all check strips	213.6
Average number of feet of live stem per acre	32.0
Feet of live stem in average bush	1.0
Number of leaves on average bush	20.9
Height above ground of the average bush (feet)	0.5
Percentage of bushes in exposed positions	11.2
Percentage of bushes in ½-screened positions	44.9
Percentage of bushes in screened positions	43.9

TABLE VII. LOSSES TO THE TOTAL AND DISTRIBUTED STOCKING DUE TO DAMAGE CAUSED BY THE BLISTER RUST FUNGUS

Sample Strip Number				I	II	III	IV	Totals	Percentages
Total Stocking Losses		No. Healthy Trees Plus No. Trees Surviving Though Inf.	1941					475	94.8
			1946	89	207	83	166	545	92.8
		No. Trees Infected & Lost	1941					26	5.2
			1946	11	16	6	9	42	7.2
		Total No. Trees	1941					501	100.0
			1946	100	223	89	175	587	100.0
Distributed Stocking Losses — By Milacre Units	In 1941	No. Units Stocked		68	119	57	87	334	30.4*
		No. Units Stocked But Trees Infected & Lost		2	5	1	2	10	3.0**
	Total No. Units			280	380	280	160	1100	100.0
	In 1946	No. Units Stocked		72	138	64	92	366	33.3*
		No. Units Stocked But Trees Infected & Lost		6	6	3	4	19	5.2**
Distributed Stocking Losses — By 4-milacre Units	In 1941	No. Units Stocked		46	61	32	36	175	63.6*
		No. Units Stocked But Trees Infected & Lost		1	0	0	1	2	1.1**
	Total No. Units			70	95	70	40	275	100.0
	In 1946	No. Units Stocked		48	66	38	36	188	68.4*
		No. Units Stocked But Trees Infected & Lost		3	0	1	2	6	3.2**

(*) Per cent of full stocking. (**) Per cent of stocked units.

Results of the 20 per cent check show that besides the 187 bushes with 607 feet of live stem per acre removed by the eradication crews in 1946 there remain on the area about 32 undetected bushes with 32 feet of live stem per acre. This number of missed bushes is believed to be about average considering the difficulties encountered while searching for such small, well-screened bushes. The average residual bush has about 1 foot of live stem supporting about 21 leaves. It reaches a height of about one-half foot above ground level, is usually partially or completely screened by surrounding vegetation, and is infected by the blister rust fungus in about four out of five cases.

5. Permanent Sample Strip Ribes Data for 1946.

According to plan, the ribes and white pine reproduction located on the four permanent sample strips received their initial inspection during the latter part of August, 1946. Pine infection and stocking estimates based on this inspection have been presented in parts 3 and 4 of this section, hence only ribes data are included in Table VIII below.

TABLE VIII. CHARACTERISTICS AND DEGREE OF INFECTION OF SAMPLE STRIP RIBES, 1946

Sample Strip Number	Number of Ribes Bushes on Strip	% of Ribes Bushes Infected	Total Feet of Live Stem, All Bushes	Feet of Live Stem Per Average Bush	Height Above Ground of Average Bush	% of Bushes in Exposed Positions	% of Bushes in ½-Screened Positions	% of Bushes in Screened Positions	Number of Leaves Per Average Bush	% of Leaves Infected Per Average Bush	Number Square Mm. Live Telia-bearing Leaf Surface Per Average Bush
I	10	70.0	13.0	1.3	0.5	20.0	30.0	50.0	25.6	26.2	105.8
II	31	67.7	15.1	0.5	0.3	12.9	38.7	48.4	9.1	36.4	158.1
III	22	81.8	14.8	0.7	0.4	4.5	40.9	54.6	11.8	45.0	162.8
IV	8	75.0	3.6	0.4	0.3	25.0	50.0	25.0	9.4	64.0	60.8
Totals	71		46.5								
Averages		73.2		0.7	0.4	12.8	39.4	47.8	12.3	38.3	141.2

The estimate of the number of ribes bushes per acre based on the small sample contained in the four strips is double that based on the 20 per cent check. There were 71 bushes found on the 1.1 acres contained in the sample strips, or approximately 65 bushes per acre. The characteristics of the average sample strip bush are similar in most respects to those of the average 20 per cent check bush. The sample strip bush is slightly smaller, lower to the ground, and has fewer leaves than the 20 per cent check bush but is almost identical as to its screening and its degree of infection by the blister rust fungus.

The estimates show that about three-quarters to four-fifths of the study area bushes were infected during 1946. The amount of sporidial inoculum which the infected bushes were capable of producing during late August and September periods when pine infection usually takes place is more important than the proportion of bushes which is infected. Measures

of the amount of sporidial inoculum available during the critical periods are the percentages of ribes leaves which are infected, or better, the ribes leaf surface area which bears live telia during the critical periods. Table IX shows that during late August, 1946, the average bush had about 40 per cent or 5 of its 12 leaves infected and that it supported about one and one-half square centimeters (141.2 sq. millimeters) of live telia-bearing leaf surface. The telia-bearing leaf surface would probably have been greater had not a fairly hot and dry early autumn plus an early frost resulted in premature casting of many infected leaves and in many rust leaf-spots becoming necrotic.

It has already been pointed out that a true measure of the infective potential of these small ribes cannot be obtained until pine infection has been measured following a year which is extremely favorable to rust spread. 1941 was such a year but rust and ribes concentrations on the study area were not as required for this study. Since it is not believed that a year truly favorable for rust spread has occurred between 1942 and 1945, and since 1946 has all the indications of being another unfavorable year, this study must be continued until one or more wave-like years occur in order to obtain the desired information.

Summary

(1) A new study aimed at determining the infective potential of small R. lacustre bushes, residual after hand eradication work, has been established on the Deception Creek drainage, Coeur d'Alene National Forest, Idaho.

(2) Weather data recorded near the study area bear out the generally accepted belief that 1941 was an exceptionally favorable year for blister rust spread in the western white pine type of northern Idaho. Despite this fact, an estimated 180 ribes per acre with live stem totaling 100 feet caused only one per cent damage to the 4-milacre units then stocked with white pine. Since 1941, the 4-milacre stocking damage has increased to about three per cent.

(3) The completion of the study now hinges on the occurrence of another combination of climatological factors as in 1941. Four permanent sample strips have been established on the study area to observe spread of the rust from typical small bushes during a favorable year.

(4) Following eradication work performed this season, a 20 per cent check showed 32 ribes and 32 feet of live stem per acre remaining on the area. The residual bushes are characteristically small, low to the ground, well-screened with surrounding vegetation, and infected with the blister rust fungus.

(5) Rust infection of the average residual ribes bush during 1946 was probably subnormal, even for the average year. The amount of pine infection occurring in the years 1942 to 1945 is believed small and pine infection during 1946 appears to have been negligible. This necessitates the continuation of this study in order that the infective potential of small ribes bushes may be determined during a year truly favorable for ribes and pine infection.

Spokane, Washington
June 18, 1947
RTB/t

Second Year Results

The four permanent sample strips received their annual inspection for 1947 from August 17-21. Tables IX and X show the losses in pine and the degree of infection of the sample strip ribes, respectively.

It is noteworthy that while visible blister rust damage to all strip pines has almost doubled since 1946 (7.2 to 13.3%), the losses in white pine growing space have not been as great. In the same time, losses to stocked milacres have increased about 50 per cent (5.2 to 8.0%); those to stocked 4-milacres about 80 per cent (3.2 to 5.7%). All of this newly discovered infection had its origin during the years following 1941, the majority of it taking place in 1943 and 1944. Despite increased losses to the reproduction stand new trees are continuing to become established at a rate which exceeds the losses caused by the rust.

A comparison of Tables VIII and X will show that although the average sample strip ribes bush is slightly larger and higher above the ground than in 1946, fewer of the bushes are infected and only about one-quarter as much live telia-bearing leaf surface is present. Until time of inspection in late August, 1947 also appeared to be a year unfavorable for rust spread.

Spokane, Washington
October 8, 1947
RTB/t

TABLE IX. LOSSES TO THE TOTAL AND DISTRIBUTED STOCKING DUE TO DAMAGE BY THE BLISTER RUST FUNGUS, 1946 - 1947

Sample Strip Number				I	II	III	IV	Totals	Percentages
Total Stocking Losses		No. Healthy Trees Plus No. Surviving Though Infected	1946	89	207	83	166	545	92.8
			1947	89	222	84	173	568	86.7
		No. Trees Infected & Lost	1946	11	16	6	9	42	7.2
			1947	24	27	19	17	87	13.3
		Total No. Trees	1946	100	223	89	175	587	100.0
			1947	113	249	103	190	655	100.0
Distributed Stocking Losses By Milacre Units	In 1946	No. Units Stocked		72	138	64	92	366	33.3*
		No. Units Stocked But Trees Infected & Lost		6	6	3	4	19	5.2**
	Total	No. Units		280	380	280	160	1100	100.0
	In 1947	No. Units Stocked		74	148	134	96	452	41.1*
		No. Units Stocked But Trees Infected & Lost		9	13	9	5	36	8.0**
Distributed Stocking Losses By 4-Milacre Units	In 1946	No. Units Stocked		48	66	38	36	188	68.4*
		No. Units Stocked But Trees Infected & Lost		3	0	1	2	6	3.2**
	Total	No. Units		70	95	70	40	275	100.0
	In 1947	No. Units Stocked		48	66	43	36	193	70.2*
		No. Units Stocked But Trees Infected & Lost		5	2	3	1	11	5.7**

(*) Per cent of full stocking. (**) Per cent of stocked units.

TABLE X!. CHARACTERISTICS AND DEGREE OF INFECTION, SAMPLE STRIP RIBES, 1947

Sample Strip Number	Number of Ribes Bushes Examined on Strip	% of Ribes Bushes Infected	Total Feet of Live Stem, All Bushes on Strip	Feet of Live Stem Per Average Bush	Height Above Ground of Average Bush	% of Bushes in Exposed Positions	% of Bushes in ½-screened Positions	% of Bushes in Screened Positions	Number of Leaves Per Average Bush	% of Leaves Infected Per Average Bush	Number of Square Mm. Live, Telia-bearing Leaf Surface Per Average Infected Bush
I	14	100	16.2	1.2	0.7	0	43	57	27	42	20
II	34	94	22.9	0.7	0.5	3	26	71	12	49	42
III	38	92	30.0	0.3	0.5	8	39	53	17	43	41
IV	7	86	3.9	0.6	0.4	0	71	29	8	70	15
Totals	93		73.0								
Averages		87		0.8	0.5	4	38	58	16	45	36

Third Year (1948) Results

The sample strips received their third annual inspection on September 1, 2, and 9, 1948. Table XI shows the pine losses due to blister rust, comparing 1946 and 1948. Table XII shows the size of the sample strip ribes and their degree of rust infection in 1948.

Considering the total number of white pines and the number of white pines rust damaged (tree basis stocking losses), the damage to pine is still increasing on Ames Creek but at a much less rapid rate. A comparison of tables IX and XI shows that damage to all trees was 7.2 per cent in 1936, 13.3 per cent in 1947, and 15.4 per cent in 1948. The sudden drop in rate of increase is due to the fact that during 1948 only the last few cankers originating in the moderately favorable rust year of 1944 became visible, and that 1945 and 1946 were apparently not very favorable years for rust spread. In 1946 the ribes on the area were reduced from 187 bushes with 607 feet of live stem per acre to 32 bushes with 32 feet of live stem per acre. This eradication rework was done before the fall season of rust spread in 1946. The rust has continued to spread, however, but has visibly infected and damaged only about one per cent of the trees on the area since reworking. The majority of the 1946 infection is probably visible this fall. No certain 1947 infection has been found.

Tree basis rust losses exceed unit basis rust losses (white pine stocked milacres and 4-milacres depopulated of white pine by the rust) as in previous years. The tree basis loss in 1948 is 15.4 per cent while the loss in white pine stocked milacres is 11.4 per cent, in 4-milacres 6.2 per cent. Despite the new rust losses the total uninfected and harmlessly infected stand has increased from 516 to 535 established white pines per acre between 1947 and 1948. Many 1946 and 1947 white pine seedlings not yet recorded as established trees were noted in 1948, indicating that new trees will continue to become established in the stand.

The average sample strip ribes has increased in size (0.8 to 1.0 feet of live stem), in percentage of its leaves infected (45 to 58 per cent), and in the amount of live, telia-bearing leaf surface present (36 to 51 sq. mm.) over the 1947 average bush. Average bush height and number of leaves are the same as in 1947 (½ foot and 16 leaves, respectively). Increased brush and herbaceous cover has resulted in more of the bushes being screened from direct air currents than was the case in 1947. These relationships are seen by comparing Tables X and XII.

Although the medium and small-sized R. lacustre bushes remaining on Ames Creek apparently have some infective potential, as witnessed by their ability to cause about one per cent damage in the susceptible 0-10-year-old stand, it remains for a year truly favorable for rust spread to demonstrate their infective potential.

Spokane, Washington
October 18, 1948
RTB/w

TABLE XI. STOCKING LOSSES DUE TO DAMAGE BY THE BLISTER RUST FUNGUS, 1946 AND 1948.

			Sample Strip Number		I	II	III	IV	Totals	Percentages
Tree Basis Stocking Losses			No. Healthy Trees Plus No. Harmlessly Infected	1946	89	207	83	166	545	92.8
				1948	93	236	86	173	588	84.6
			No. Trees Infected & Lost	1946	11	16	6	9	42	7.2
				1948	30	33	23	21	107	15.4
			Total No. Trees	1946	100	223	89	175	587	100.0
				1948	123	269	109	194	695	100.0
Stocked Unit Basis Stocking Losses	By Milacre Units	In 1946	No. Units Stocked With WWP		72	138	64	92	366	33.3*
			No. Units Stocked With WWP But WWP Infected & Lost		6	6	3	4	19	5.2**
		Total	No. Units		280	380	280	160	1100	100.0
		In 1948	No. Units Stocked With WWP		81	152	72	100	405	36.8*
			No. Units Stocked With WWP But WWP Infected & Lost		14	18	10	4	46	11.4**
	By 4-Milacre Units	In 1946	No. Units Stocked With WWP		48	66	38	36	188	68.4*
			No. Units Stocked With WWP But WWP Infected & Lost		3	0	1	2	6	3.2**
		Total	No. Units		70	95	70	40	275	100.0
		In 1948	No. Units Stocked With WWP		48	67	43	36	194	70.5*
			No. Units Stocked With WWP But WWP Infected & Lost		4	4	4	0	12	6.2**

(*) Per cent of total number (1100 or 275) units stocked with WWP. (**) Per cent of WWP stocked units.

TABLE XII. CHARACTERISTICS AND DEGREE OF INFECTION, SAMPLE STRIP RIBES, 1948.

Sample Strip Number	Number of Ribes Bushes Examined on Strip	% of Ribes Bushes Infected	Total Feet of Live Stem, All Bushes on Strip	Feet of Live Stem Per Average Bush	Height Above Ground of Average Bush	% of Bushes in Exposed Positions	% of Bushes in ½-Screened Positions	% of Bushes in Screened Positions	Number of Leaves Per Average Bush	% of Leaves Infected Per Average Bush	No. of Sq. Millimeters Live, Telia-Bearing Leaf Surface Per Average Infected Bush
I	17	82	23.6	1.4	0.6	0	47	53	25	53	34
II	34	97	29.4	0.9	0.5	0	29	71	14	70	98
III	37	84	38.5	1.0	0.6	3	19	78	17	51	25
IV	10	90	5.4	0.5	0.4	0	10	90	6	55	22
Totals	98		96.9								
Averages		89		1.0	0.5	1	27	72	16	58	51

Fifth Year (1950) Results

The sample strips received their fifth year annual inspection August 16 through 28, 1950. Table XIII shows the white pine losses due to blister rust, comparing rust development over the 5-year period, 1946-50. Table XIV shows the size of sample strip ribes and degree of ribes infection in 1950.

Blister rust damage is continuing to increase on Ames Creek whether shown in terms of total trees damaged or in terms of milacre or 4-milacre quadrats depopulated of white pine by blister rust. While the annual increase in amount of damage is small (i.e., less than 1 percent per year 4-milacre damage), the accumulated damage in the 13 years since initial rust infection has now reached 18.7 percent of trees damaged, 13.2 percent milacres damaged, or 9.3 percent of 4-milacres damaged. Obviously, rework is indicated on this and similar small bush areas.

The average sample strip ribes has again increased in size since last inspected. In 1946, the average bush contained 0.7 feet of live stem, had a height of 0.4 feet, and was about half-screened by other vegetation. By 1948, it had 1.0 feet of live stem, a height of 0.5 feet, and was about fully screened. By 1950, it had 1.5 feet of live stem, a height of 0.7 feet, and was about fully screened. Bushes on the two open strips (I and III) were larger and higher than those in the two shelterwood strips (II and IV), the average differences being 1.8 FLS and 0.8 feet height vs. 1.1 FLS and 0.5 feet height, respectively.

In 1943, it was found that there was an average of 622 ribes seedlings per acre in the open areas vs. 254 in the shelterwood. Now the picture is reversed, successive eradications having been most effective on the open areas which supported the largest, most visible bushes. The greatest density in bushes per acre will now be found within the shelterwood, but these bushes are small, low, well screened, and otherwise difficult to find by hand eradication methods.

Probably another year really favorable for spread of rust will not be necessary to complete this study of the infective potential of small Ribes lacustre bushes. It can now be seen that damage, accumulating slowly over a number of minor "wave years," soon becomes impressive enough to indicate that rework will probably be necessary.

It is hoped that if the study is continued beyond 1950 that the stocking and damage estimates can be revised in the light of more recent information. After 1948, methods of making stocking and rust damage appraisals in this region were standardized, using a 2-milacre stocking quadrat and considerable new information on the behavior of white pine in competition with other conifers. For purposes of keeping annual data uniform for a 5-year period, this study, begun in 1946, has not been revised according to these new stocking and rust damage survey methods. Had revisions been made, the rust damage indicated in the 1950 results would probably be larger.

Spokane, Wash.
Feb. 16, 1951
RTB/t

TABLE XIII. STOCKING LOSSES DUE TO DAMAGE BY THE BLISTER RUST FUNGUS, 1946 AND 1950

				Sample Strip Number					
		% infected		I	II	III	IV	Totals	Percentages
Tree Basis Stocking Losses		Number Healthy Trees Plus Harmlessly Infected Trees	1946	89	207	83	166	545	92.8
			1950	104	258	102	196	660	81.3
		Number Trees Fatally Infected and Dead	1946	11	16	6	9	42	7.2
			1950	37	54	35	26	152	18.7
		Total Number of Trees	1946	100	223	89	175	587	100.0
			1950	141	312	137	222	812	
Stocked Quadrat Basis Stocking Losses		% infected		.11 & .26	.14 & .17	.7 & .26	.5 & .12		
	Milacre Quadrats, 1946	Number White Pine Stocked Quadrats		72	138	64	92	366	33.3*
		Number Quadrats with All White Pines Fatally Infected or Dead		6	6	3	4	19	5.2**
		Total Number Milacre Quadrats		280	380	280	160	1,100	
	Milacre Quadrats, 1950	Number White Pine Stocked Quadrats		90	175	88	110	463	42.1*
		Number Quadrats with All White Pine Trees Fatally Infected or Dead		17	20	19	5	61	13.2**
	4-Milacre Quadrats, 1946	Number White Pine Stocked Quadrats		48	66	38	36	188	68.4*
		Number Quadrats with All White Pines Fatally Infected or Dead		3	0	1	2	6	3.2**
		Total Number 4-Milacre Quadrats		70	95	70	40	275	
	4-Milacre Quadrats, 1950	Number White Pine Stocked Quadrats		52	70	47	36	205	74.5*
		Number Quadrats with All White Pines Fatally Infected or Dead		3	4	10	2	19	9.3**

(*) Percent Total Number Quadrats (1,100 or 275) Stocked with WWP.
(**) Percent Total Number WWP Stocked Quadrats Lost.

TABLE XIV. CHARACTERISTICS AND DEGREE OF INFECTION, SAMPLE STRIP RIBES, 1950

Infection rate	Sample Strip Number	Number of Ribes Examined on Strip	Percent of Ribes Infected	Total Feet of Live Stem	Feet of Live Stem Per Average Ribes	Height Above Ground of Average Ribes (Ft.)	Percent of Ribes in Exposed Positions	Percent of Ribes in Half-Screened Positions	Percent of Ribes in Screened Positions	Number of Leaves Per Average Ribes	Percent of Leaves Infected Per Average Ribes	Number of Square Millimeters Live, Telia-Bearing Leaf Surface Per Average Infected Ribes
.037	.28 I	54 15	100	37.8	2.5	0.9	0	33	68	48	45	175
.023	.38 II	92 35	86	44.3	1.3	0.7	0	17	83	16	55	189
.045	.28 III	150 42	98	61.7	1.5	0.7	0	43	57	27	61	350
.015	.16 IV	69 11	100	6.4	0.6	0.4	0	27	73	11	50	15
	Totals	103		150.2								
	Averages		94		1.5	0.7	0	31	69	24	55	234

McDonald & Hoff 1981 IUFRO workshop